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COMPARISON OF THE IRRIGATION OF OPEN FRACTURES OF THE LOWER LIMBS WITH NORMAL SALINE VERSUS TAP WATER IN PATIENTS PRESENTING TO ACCIDENT AND EMERGENCY OF JOS UNIVERSITY TEACHING HOSPITAL (JUTH), JOS, NIGERIA

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COMPARISON OF THE IRRIGATION OF OPEN FRACTURES OF THE LOWER LIMBS WITH NORMAL SALINE VERSUS TAP WATER IN PATIENTS PRESENTING TO ACCIDENT AND EMERGENCY OF JOS UNIVERSITY TEACHING HOSPITAL (JUTH), JOS, NIGERIA

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ABSTRACT

Infection is a major contributing factor to the morbidity and mortality associated with traumatic wounds. Tap water has been used for centuries as wound cleanser while normal saline is regarded as the most appropriate and preferred cleansing solution.

The objective of the study was to determine the outcome of irrigation of open fractures of the lower limbs with normal saline versus tap water in patients with open fractures.

A randomized prospective study was done to compare the infection rate and bacteriology of open fractures of the lower limbs when irrigated with normal saline versus tap water amongst 107 patients in normal saline group and 102 patients in the tap water group was carried out in Department of Orthopedics and Trauma, Jos University Teaching Hospital, Jos using simple random sample method.

The mean age for normal saline group was 37.2±1.4 years and 39.4±1.4 years for the tap water group. The male to female ratio was 3.1:1 in the normal saline group and 3.5:1 in tap water group. Ninety-five (45.5%) of the 209 patients had their wounds infected, 50 (46.7%) from normal saline group and 45 (44.1%) from tap water group. No statistically significant difference in infection rate in the two groups (P=0.705). No statistically significant difference in distribution of bacterial isolates from the wounds of both groups (P=0.886).

It can be deduced that tap water is an effective alternative to normal saline for irrigation of open fractures.

INTRODUCTION

Infection is a major contributing factor to the morbidity and mortality associated with open fractures.[1, 2] In view of the important role of irrigation solution on preventing wound infection, a continuous search is being done on an ideal decontamination solution.[3] Tap water has been used for centuries as wound cleanser while normal saline is regarded as the most appropriate and preferred cleansing solution.[4-6] However, cost can limit its use especially when large amount is required or when faced with a mass casualty scenario.[7]

Open fractures most commonly occur in the lower limb, tibial diaphysis and distal tibia are the most commonly affected (37.5%).[8] The infection rate of open fractures of the lower limb varies depending on Gustilo and Anderson's class, time of presentation and intervention.[9] In a study of open fractures of the lower limb carried out in Obafemi Awolowo University, Ile Ife, Osun State of Nigeria, wound infection was the most common complication with 24 out of 47 open tibia fractures and 3 out of 12 femoral fractures infected.[10] Wound infection results in prolonged hospital stay and increased trauma care and treatment cost; in general wound management practices become more resource demanding.[11, 12]

Infection is a major factor that delays wound healing especially in traumatic wounds. In view of the important role of irrigation solution in preventing wound infection, a continuous search is being made for an ideal decontamination solution.[7, 12] Tap water has been used for centuries as wound cleanser without evidence of adverse effect or associated infection risk.[12] Normal saline is regarded as the most appropriate and preferred cleansing solution because it is a nontoxic isotonic solution that does not damage healing tissues.[12] However, cost can limit its use especially when large amount is required.[5]

The objective of the study was to determine the outcome of irrigation of open fractures of the lower limbs with normal saline versus tap water in patients presenting to accident and emergency of Jos University Teaching Hospital (JUTH), Jos, Nigeria.

PATIENTS AND METHODS

This was a randomized prospective study carried out in Department of Orthopedics and Trauma, Jos University Teaching Hospital, Jos from April 2013 to March 2014. The purpose of the study was to compare the infection rate and bacteriology of open fractures of the lower limbs using normal saline and tap water as wound irrigants and to assess the effectiveness of tap water for wound irrigation.

The inclusion criteria considered were adult patients (18 years and above) who presented to Emergency Department of JUTH, Jos with open fractures of the lower limbs from April 2013 to March 2014, within 24 hours of injury, with Gustilo and Anderson's Grade I, II, III A and III B injuries, and Hemoglobin concentration not less than 10 gram percent. While patients who had debridement in other centers prior to presentation to Accident and Emergency JUTH, Jos and patients with medical condition like diabetes mellitus, obesity, cardiac failure, renal failure, malnutrition, severe peripheral vascular disease, immune suppressive condition (e.g., Human Immune Deficiency Virus infection),

patients on cytotoxic and steroid therapy were excluded.

The minimum sample size of the study was calculated to be 93 using the formula for calculating sample size for the comparison of two proportions. [5]

A thorough history and physical examination was performed to rule out other injuries and diseases in the exclusion criteria. And base line investigations were carried out where only those within normal limit were recruited.

Parenteral prophylactic antibiotics were administered pre, per and post-operatively as required. Intravenous Ceftriaxone and Metronidazole were the antibiotics commonly used for prophylaxis during this study. Tetanus prophylaxis was administered.

Operation site preparation was done with Hibitane and surgical spirit and draping done exposing the operation site. Wound debridement and irrigation with normal saline or tap water was done in Accident and Emergency theatre under regional or general anesthesia. Three, six, and nine litres of normal saline or tap water were used for irrigation of Gustilo and Anderson's types I, II, and III wounds respectively. The source of tap water was the treatment plant of Jos University Teaching Hospital. Tap water specimen was taken monthly from Accident and Emergency, theatre then analyzed, and no pathogenic organisms was found in any of the specimen.

Primary wound closure was done using nylon sutures for Gustilo and Anderson's I,II and IIIA injuries presenting within 6 hours and delayed primary closure for wounds presenting after 6 hours of injury. Grade IIIB injuries were left open for wound dressing and were subsequently covered with skin graft or flap.

All wounds were inspected on days 2, 5, 7, 14 and during each observation, classic signs of infection such as spreading erythema, swelling, warmth, purulent and bloody drainage and crepitation were recorded for each patient.

Ethical approval was obtained from the Jos University Teaching Hospital Ethical review board.

RESULTS

During the study period, a total of 244 patients who fulfilled the inclusion criteria were initially entered into the study. Thirty-five (35) patients were lost to follow up; 11 in normal saline group and 18 in tap water group. Two hundred and nine (209) patients with open fractures of the lower limb were successfully followed up. One hundred and seven (107) formed the control group (51.2%) in which wound irrigation was done with normal saline and 102 (48.8) formed the test group in which irrigation was done with tap water.

The overall mean age was (38.3±14.06) years. The mean age for normal saline group was (37.2±1.4) years and (39.4±1.4) years for the tap water group. There was no statistically significant difference in age distribution between the normal saline and the tap water group (P=0.510).

A total of 158 (75.6%) of all patients in the study were males and 51 (24.4) were females. The male to female ratio was 3.1:1 in the normal saline group and 3.5:1 in tap water group. There was no statistically significant difference in the sex distribution between the two groups (P=0.972).

Automobile accident (74) and gunshot wounds (62) accounted for most of the cases in the study in both groups. The infection rate of automobile accident wounds in the normal saline group was 38.5% while it was 37.1% in the tap water group. It was 53.1% and 56.7% for gunshot wounds in normal saline and tap water group respectively. The highest

infection rate was in blast wounds in both normal saline (66.7%) and tap water (71.4) group. The only case of collapsed wall was infected. Machete cut in the tap water group had the lowest infection rate (28.6%). Statistically, there was no significant difference in infection rate by etiology in both the control and test group (P=0.856 and 0.071) respectively.

Ninety-five (95) out of 209 patients (45.5%) had their wounds infected, 50 (46.7%) from normal saline group and 45 (44.1%) from tap water group. There was no statistically significant difference in the infection rate in the two groups (P=0.705).

Table 1

Relationship between irrigation solution and wound infection among the two groups

IRRIGANT	**Frequency**	**Infected**	**Percentage (infection rate)**	**Chi-square**	**P-value**
Normal Saline	107	50	46.7	0.144	0.705
Tap Water	102	45	44.1		
Total	**209**	**95**	45.5		

The highest infection rate occurred in the 30-60 years age group of the normal saline group in which 28(55%) out of the 51 patients developed wound infection while the lowest infection rate occurred in >60 years age group of the normal saline group in which 4 (33%) of the 12 patients developed wound infection. In the tap water group, the infection rate is highest in age group >60 years (53%) and lowest in age group <30 years (37%). The difference in infection rate in the three age groups is not statistically significant in both the normal saline and the tap water groups, P-value of 0.243 and 0.475 respectively. Details shown on table 2

Table 2

Distribution of wound infection in different age groups

Age group (years)	**Normal Saline**		**Tap Water**		**Total**
	Infected / frequency (%)	**Not infected/ frequency (%)**	**Infected/ frequency (%)**	**Not infected/ frequency (%)**	
< 30	18(41)	26(59)	14(37)	24(63)	82
30 – 60	28(55)	23(45)	22(47)	25(53)	98
>60	4(33)	8(67)	9(53)	8(47)	29
Total	**50(46.7)**	**57(53.3)**	**45(44.1)**	**57(55.9)**	**209**
Chi-square	2.832		1.491		
P-value	0.243		0.475		

Of the 81 male patients in the normal saline group, 38 (47%) of them had their wounds infected while 12 (46%) of the 26 female patients developed wound infection. In the tap water group 39 (51%) of 77 male patients developed wound infection while 6 (24%) of the 25 female patients developed wound infection. Details shown on table 3

Table 4

Sex distribution of wound infection

Sex	**Normal Saline**		**Tap water**		**Total**
	Infected / frequency (%)	**Not Infected/ frequency (%)**	**Infected /frequency (%)**	**Not Infected /frequency (%)**	
Male	38(47)	43(53)	39(51)	38(49	158
Female	12(46)	14(54)	6(24)	19(76)	51
Total	**50(46.7)**	**57(53.3)**	**45(44.1)**	**57(55.9)**	**209**
Chi-square	0.005		5.436		
P-value	0.946		0.020**		

Automobile accident (74) and gunshot wounds (62) accounted for most of the cases in the study in both groups. The infection rate of automobile accident wounds in the normal saline group was 38.5% while it was 37.1% in the tap water group. It was 53.1% and 56.7% for gunshot wounds in normal saline and tap water group respectively. The highest infection rate was in blast wounds in both normal saline (66.7%) and tap water (71.4) group. The only case of collapsed wall was infected. Machete cut in the tap water group had the lowest infection rate (28.6%). Details are shown on table 5. Statistically, there was no significant difference in infection rate by etiology in both the control and test group (P=0.856 and 0.071) respectively.

Table 5

Distribution of wound infection by cause of trauma

Cause of Trauma	**Normal Saline**			**Tap water**			**Grand Total**
	Infected frequency (%)	**Not Infected frequency (%)**	**Total**	**Infected frequency (%)**	**Not Infected frequency (%)**	**Total**	
Automobile	15(38.5)	24(61.5)	39	13(37.1)	22(62.9)	35	74
Gun shot	17(53.1)	15(46.9)	32	17(56.7)	13(43.3)	30	62
Machete cut	6(37.5)	10(62.5)	16	4(28.6)	9(71.4)	13	29
Blast	4(66.7)	2(33.3)	6	5(71.4)	2(28.6)	7	13
Fall from height	4(57)	3(43)	7	4(40)	6(60)	10	17
Industrial accident	3(50)	3(50)	6	2(28.7)	5(71.3)	7	13
Collapsed wall	1(100)	0(0)	1	-	-	-	1
Total	**50(46.7)**	**57(53.3)**	**107**	**45(44.1)**	**57(55.9)**	**102**	**209**
Chi-square	2.607			10.116			
P-value	0.856			0.071			

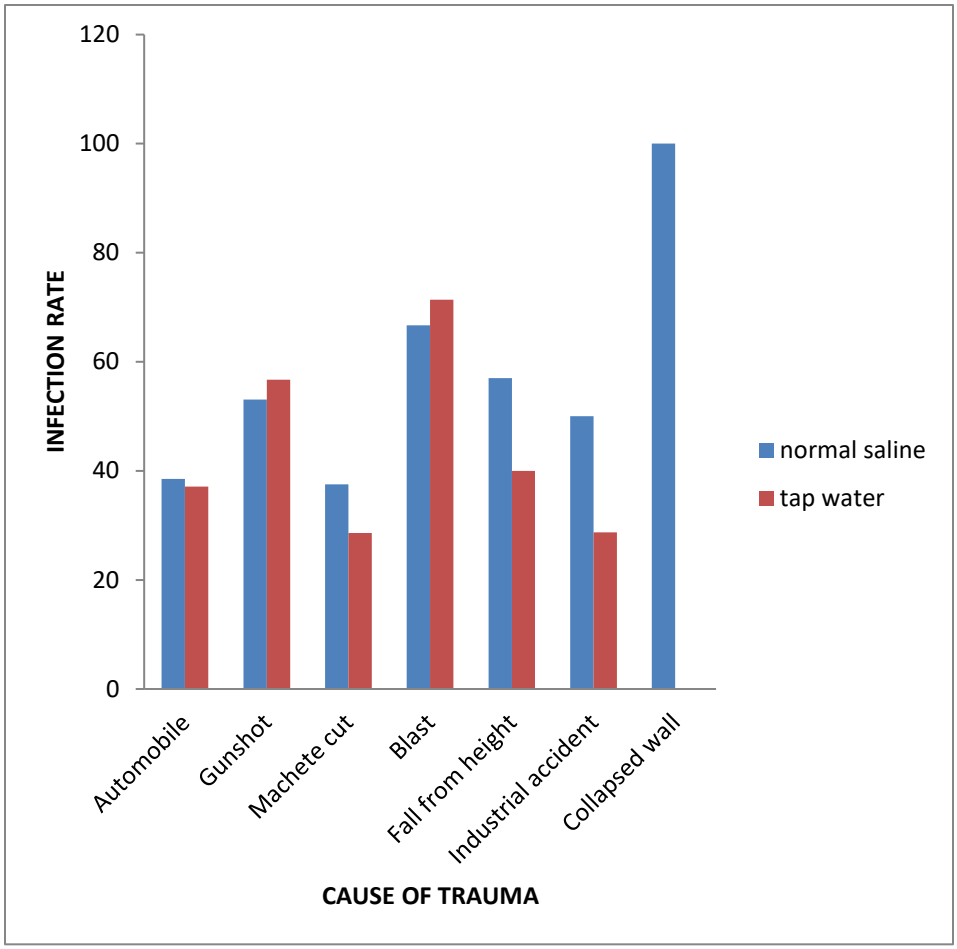

Figure 1: Distribution of wound infection rate by cause of trauma

DISCUSSION

Irrigation of wounds to remove bacteria and foreign materials so as to prevent infection and create a wound environment optimal for healing is essential in wound management.[12, 13] A variety of cleansing solutions exists and their selection is based on cleansing effectiveness, safety and cost.

In this study the overall infection rate was 45.5%. The finding of infection rate of 46.7% in open fractures of the lower limb irrigated with normal saline and 44.1% in those irrigated with tap water compares favorably with some earlier studies.[14] Ikem et al in Ile Ife reported an infection rate of 39.3% in open fractures of the femur and tibia irrigated with normal saline.[14] This however has a lower infection rate compared to the 46.7% in the normal saline group in this study. This is probably due to higher number of gunshot wounds and some blasts injuries in this study resulting in higher Gustilo and Anderson's grade of wounds with higher infection rate as shown by the result of this study. Fifty nine percent of the cases in the study in Ile-Ife resulted from automobile accident as against 35% in this study.

The infection rate in this study is comparably higher than the study by Museru et al in Tanzania which reported a lower infection rate of 29% in the tap water group and 35% in the normal saline group.[15, 16] However, their study included open fractures involving other parts

of the body in addition to open fractures of the lower limbs. The 46.7% and 44.1% infection rate in saline and tap water group respectively in this study is higher compared to infection rate of 8.6% and 8.3% in normal saline and tap water group respectively in a study by Mirshamsi et al in Yazd, Iran.(12) Similarly, a prospective double blind study done at New York, USA by Moscati et al on uncomplicated soft tissue laceration showed a lower infection rate of 6.4% for normal saline and 4.9% for tap water group.[17] The low infection rate in the Iraq and USA studies may probably be due to early presentation, availability of antibiotics, better theatre facilities and the fact that their study was on soft tissue lacerations. In this study there was no statistically significant difference in infection rate between the test and the control groups though, rates of 46.7 and 44.1% seems clinically significant. This is in keeping with the outcome of previous studies which support that tap water is comparable to normal saline and suggests the effectiveness of tap water for irrigation of open fractures.[10, 12, 18, 19]

In this study, most of the patients were in the age range 30-60 years accounting for 47.7% of cases in the normal saline group and 46.1 of all cases in the tap water group. This may be because of the greater vulnerability of this active age group to trauma. This age group also took active part in the sectarian crisis in Jos and its environment during the study period. Previous studies by Ikem et al and Mirshamsi et al also showed that most of their patients were in this same age group.[10, 12] Similar to this study, they also found that there was a relative age related incidence rate of wound infection in both groups and its incidence increased with increase in patient's age. In this study, infection rate increased with increase in patient's age in both groups but there was no statistically significant difference in infection rate in the age groups in both normal saline and tap water groups. The reasons for increased wound infection rates in older age group may include poor nutrition and decreased immune response.[1]

The sex ratio in the study also agrees with other reports and further emphasizes the greater vulnerability of males to trauma. The infection rate is statistically significantly lower in females compared to males in the tap water group (P=0.020) similar to other previous reports[19, 21] but contrary to others.(6, 20) There is no statistically significant difference in infection rate in males and females in the normal saline group. The reason for the high infection rate in males may be due to their greater vulnerability to higher grades of wounds and un-excluded underlining diseases.

Automobile accident and now gunshot injuries are the most common causes of mortality and morbidity in the most productive period of life world-wide.(8, 10) This explains why automobile accident and gunshot wounds accounted for 65.7% of all patients in this study. The reason for the high infection rate in gunshot and blast injuries in both groups was because they were associated with higher grades of wounds (grade 111).

CONCLUSION

The infection rate of open fractures of the lower limbs is 45.5%. This is comparable to reports from other parts of Nigeria. There is no difference in infection rate of wounds irrigated with either normal saline (46.7%) or tap water (44.1%) solution, with a clinical trend towards fewer wound infection in tap water group, making it a safe and cost-effective alternative to normal saline for wound irrigation.

The use of tap water for irrigation of open fractures should be encouraged because it is

efficient, readily available and cost-effective alternative to normal saline. However, the source and sterility of the tap water should be ascertained. Analysis of tap water to be used for wound irrigation should be done periodically for bacteria. Tap water of lesser quality than was used in this study may produce different effects.

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